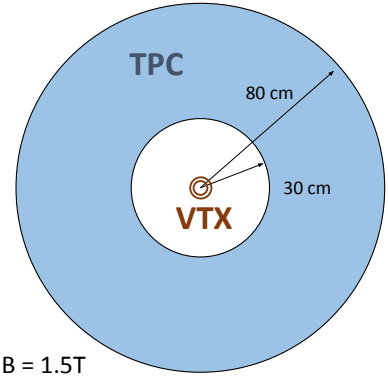
Outline

I was asked to give a high-level overview of how the TPC software works

Most of the following slide have largely been shown before, but perhaps not everyone has seen them. If any detail you want to know is missing, just interrupt

A sPHENIX Tracking Solution: TPC & 2 Pixel Layers

Design parameters and performance consistent with ILC TPC prototypes



TPC

- T2K gas volume from 30cm to 80cm
- $|y| < 1 \rightarrow z_{max} \sim \pm 80$cm
- 60 radial readout layer with $\Delta r \sim 8$mm
- Readout plane with 1.2mm pads in $r\varphi$
  - approximately 350,000 readout channel
- Assume 40 MHz FADC $\rightarrow$ $\Delta z \sim 2$mm
  - approximately 400 samples per readout channel

VTX layers 1 & 2

- Silicon tracker design

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T2K Gas and Response of Readout Plane

Gas properties (Ar(95%) CF_4(3%) Isob(2%)), based on ILC prototype measurements and verified with Magboltz, ionization from PDG:

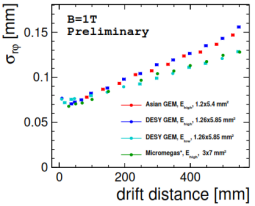
- N_t = 38 electrons/keV
- $v_{drift} \approx$ 6 cm/μs at ~ 150 V/cm
- $D_t \approx$ 57 μm/√cm in 1.45 T field
- $w_t \approx$ 2.2
- $X_0 \approx$ 11633 cm

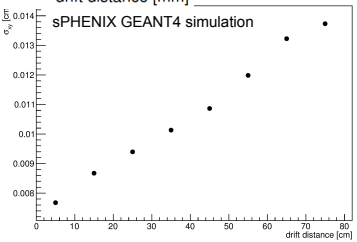
$$\sigma_{r\varphi}^2 = \frac{D_t^2 z}{N_t} + \sigma_0^2$$

$$\sigma_z^2 = (1 + w_t^2)\frac{D_t^2 z}{N_t}$$

Charge sharing between 2-3 pads of 1.2mm, based on ILC prototype measurements:

- σ_{charge} = 300 μm in triple GEM
- σ_0 = 70-80 μm





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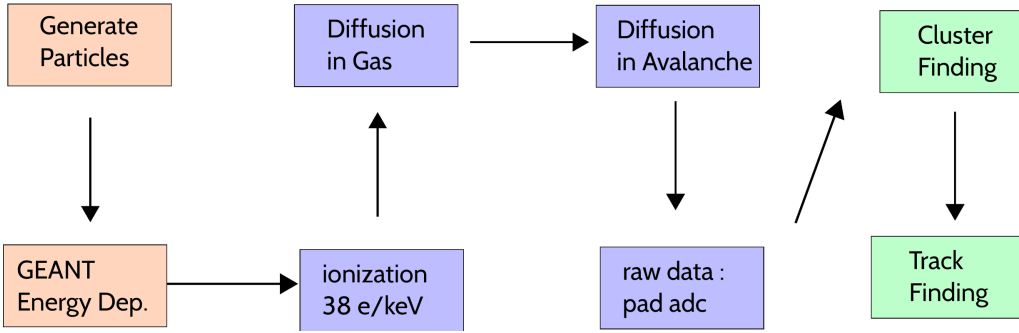
Alan Dion

Flow Chart of GEANT Simulation & Analysis



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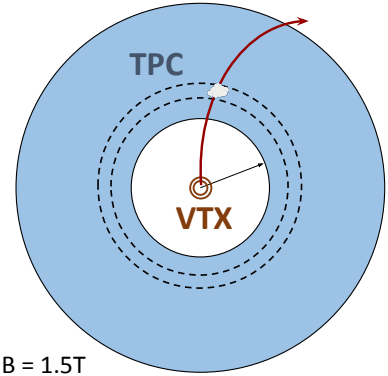
TPC Charge Cloud Generation & Diffusion



TPC in GEANT

- Record ΔE in radial drift cylinder slice
- Convert to charge cloud along track segment
- Diffuse charge cloud along z for T2K gas in 1.5 T B-field with 220 V/cm E-field
- Distribute Cloud along pads, fit with cluster-finder

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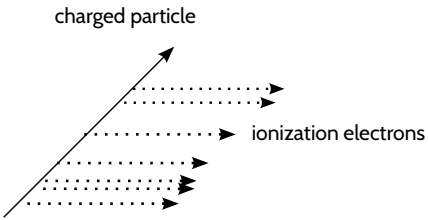
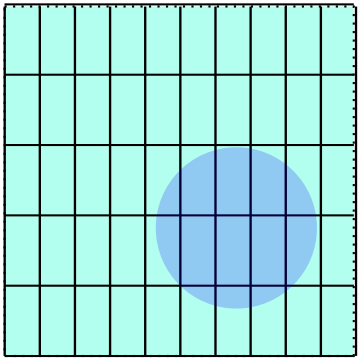
A little more detail



Poisson process done for each gas "layer"



r-phi pad plane filled with ADC from number of electrons (gain tunable through digitizer class)

Currently, clustering is done separately for each pad row, corresponding to constant radius. The pad width is the same as the discretization of the energy deposits in the gas .

On the to-do list to change after the merge!

resolution for hit reconstruction in the z-direction is just mocked up as a single number

In reality, there will be a shaper pulse which gives us timing information

Not sure how much detail we really want to add at this point

Pattern recognition

The pattern recognition roughly consists of 3 steps :

- Hough transform
  - selects a few hits per layer such that there is likely a track
  - can't do better than that due to multiple scattering, energy loss, field deformity
- Combinatorial algorithm
  - some sort of fast statistical check on remaining hit combinations which takes multiple scattering into account
  - for the SVTX, I just eat the $n_{hits}^{n_{layers}}$. Not viable for TPC
- Kalman filter
  - selects the remaining based on a variable which should closely follow a χ^2 distribution

The second step has been completely changed on the TPC branch. Should there be a flag to select the algorithm, or should the software try to figure it out from the geometry?